

Predicting mathematics well-being in secondary school students: An integrated model of self-determination and social support in Indonesia

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Abstract

Improving students' mathematical wellbeing is important because it supports their positive feelings toward mathematics and contributes to better learning outcomes. However, limited research has explored which factors influence mathematical wellbeing from the students' own perspective. This study aims to address this gap by examining both external and internal predictors, drawing on Self-Determination Theory and Social Support Theory. Data were collected from 449 secondary school students in Indonesia, and Structural Equation Modelling was conducted using SmartPLS. The findings show that five out of six proposed hypotheses were supported. Specifically, autonomy, competence, and relatedness, as well as parent support and peer emotional support, were found to have significant positive effects on students' mathematical wellbeing, whereas teacher social support did not show a significant direct effect. The structural model demonstrated strong explanatory power, with the predictors jointly explaining 70.2% of the variance in mathematical wellbeing. These findings suggest that enhancing students' mathematical wellbeing requires attention to both basic psychological needs and social support systems, particularly support from parents and peers. Interventions aimed at fostering autonomy, competence, and relatedness may be effective strategies for promoting positive experiences in mathematics learning.

Keywords:

Mathematics education, Psychology, Secondary school, Wellbeing

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1. INTRODUCTION

Mathematics is a foundational subject that supports learning across many disciplines (OECD, 2019), yet many students still experience difficulties in learning it (Jiang et al., 2022). These difficulties are often related not only to cognitive challenges but also to affective factors, such as mathematics anxiety, low interest, and low motivation, which can negatively influence students' achievement, confidence, future career choices, and overall wellbeing. These issues are also evident in Indonesia, where studies have found that mathematics is one of the least liked subjects among students (Fendrik et al., 2024; Hidayati & Shodikin, 2025; Murtafiah et al., 2023; Pramuditya et al., 2025). National reports and international assessments consistently show that Indonesia performs at a relatively low level in PISA mathematics (Wijaya et al., 2024), suggesting that many students face difficulties in developing essential mathematical competencies. One of the contributing factors is the high level of mathematics anxiety reported by students, along with low motivation and various other affective challenges that shape their learning experiences in negative ways (Delima et al., 2024; Diponegoro et al., 2024; Hutajulu et al., 2019; Listiawati et al., 2025; Prahmana et al., 2021).

To address these challenges, a growing body of research has shifted its attention toward students' wellbeing in mathematics education, often referred to as mathematical wellbeing (Hill & Hunter, 2024; Hunter & Hill, 2024). Mathematical wellbeing (MWB) reflects students' subjective experience of feeling good and functioning well in their engagement with mathematics (Hill & Hunter, 2024; Hunter & Hill, 2024). Recent empirical studies and meta-analytic findings show that mathematical wellbeing is a meaningful and culturally robust construct that relates positively to students' academic achievement (Hill & Hunter, 2024; Hunter & Hill, 2024). Importantly, mathematics-related affect (e.g., enjoyment or anxiety) is closely related to MWB, but MWB is broader than affect because it captures not only emotional experiences but also students' optimal functioning in mathematics learning. These insights indicate that improving students' learning conditions may support both their wellbeing and their educational outcomes.

Building on this need, the present study explores factors associated with MWB by drawing on Self-Determination Theory (Ryan & Deci, 2000) and Social Support Theory (Cohen & Wills, 1985). This integration is based on the assumption that mathematical wellbeing is shaped by both internal and external influences. Self-Determination Theory highlights the role of internal psychological needs such as autonomy, competence, and relatedness, whereas Social Support Theory emphasizes external sources of support from parents, peers, and teachers. By integrating these perspectives, the study offers a more comprehensive account of how internal need satisfaction and external support systems are associated with students' mathematical wellbeing, with practical implications for strengthening supportive mathematics learning environments.

1.1. Mathematical Wellbeing

Mathematical wellbeing has recently gained increasing attention in education as researchers recognize its value in understanding students' subjective experiences in learning mathematics (Hill & Hunter, 2024; Hunter & Hill, 2024). It offers a broader and more human-centered perspective by acknowledging that students' feelings, confidence, and thinking

processes are deeply interconnected during mathematics learning (Hill & Hunter, 2024; Hunter & Hill, 2024). Mathematical wellbeing reflects not only how students feel about mathematics but also how well they are able to learn and perform. When students develop stronger mathematical understanding and skills, they are more likely to feel capable and enjoy engaging with the subject, which in turn enhances their wellbeing (Pan et al., 2022).

We acknowledge that mathematical wellbeing is not shaped by a single factor. Instead, it arises from a combination of emotional, social, cognitive, and performance-related influences. Compared with traditional research that tends to emphasize isolated elements such as achievement or mathematics anxiety, mathematical wellbeing encourages us to see learners holistically. It helps us understand how students can function effectively in learning mathematics, alongside experiencing positive feelings, which may support sustained engagement and success. Mathematics-related affect is correlated with mathematical wellbeing, but wellbeing represents a broader construct than affect alone.

As a discipline-specific component of students' overall wellbeing, mathematical wellbeing has become increasingly recognized for its importance in supporting both academic development and psychological growth. Existing research suggests that students with higher levels of mathematical wellbeing tend to show better mathematics achievement and stronger learning engagement, and they are more capable of regulating emotions, maintaining self-efficacy, and sustaining motivation in mathematics learning (Pan et al., 2022). These findings suggest that mathematical wellbeing is closely related to positive learning experiences (e.g., enjoyment), but it is not identical to them and should not be treated as a simple "positive side effect". Rather, mathematical wellbeing reflects a broader state of feeling good and functioning well in mathematics learning. As such, it may serve as an important psychological resource that is associated with more productive learning behaviors and supports students' healthy development in mathematics.

Given its meaningful contributions, promoting mathematical wellbeing deserves to be a key goal of mathematics education. However, we also recognize that current research still offers limited insights into the factors that shape mathematical wellbeing and the ways in which these factors interact. Understanding what influences mathematical wellbeing, and through which pathways these influences occur, remains essential.

In terms of conceptual development, the idea of mathematical wellbeing was initially introduced by Clarkson et al. (2010). They emphasized the importance of value, suggesting that students' wellbeing grows when they perceive mathematics as meaningful and when they feel valued as mathematics learners. They also described five developmental stages through which mathematical wellbeing can be cultivated.

Building on this foundation, Hill and Hunter (2024) broadened and refined the concept. Their work made two important contributions. First, they responded to the earlier frameworks' limited consideration of the social and multidimensional nature of mathematical wellbeing. Second, they improved how the construct could be defined and measured in research. Guided by principles from positive psychology, they integrated the PERMA model and the EPOCH model to propose a more comprehensive and measurable structure of mathematical wellbeing. This framework identifies seven core dimensions, including achievement, cognition, engagement, meaning, perseverance, positive emotion, and relationships. Because of its

conceptual richness and sound measurement properties, this seven-dimension structure has been increasingly applied in current research and has become an influential approach for examining mathematical wellbeing.

1.2. Self Determination Theory

Based on Self-Determination Theory, students' autonomy, competence, and relatedness are important psychological needs that shape their motivation, learning experience, and wellbeing (Ryan & Deci, 2000). When these needs are supported, students are more likely to experience positive emotions, maintain motivation, and feel comfortable and satisfied in mathematics learning (Mata et al., 2012).

Autonomy refers to students' sense of choice and control in their learning. When students feel that they have some ownership of their mathematics learning, they are more willing to engage with tasks and persist when facing difficulties (Virtanen et al., 2019). This sense of autonomy can reduce anxiety and support more positive learning experiences. Therefore, autonomy support is expected to positively influence students' mathematical wellbeing.

Competence refers to students' belief that they are capable of learning and solving mathematical problems. When students feel competent, they are more likely to experience progress, mastery, and confidence in mathematics (Jitendra, 2019; Kusmaryono et al., 2020). This can reduce frustration and helplessness, especially when they encounter challenging tasks. Therefore, competence support is expected to positively influence students' mathematical wellbeing.

Relatedness refers to students' sense of connection, belonging, and support from teachers and peers. Supportive classroom relationships can help students feel emotionally safe and accepted in mathematics learning (Virtanen et al., 2019). When students feel supported rather than judged, they are more likely to view mistakes as part of learning. Therefore, relatedness support is expected to positively influence students' mathematical wellbeing.

Taken together, the satisfaction of these basic psychological needs may provide an important foundation for students' mathematical wellbeing. Thus, this study proposes the following hypotheses:

H1 Relatedness support positively influences students' mathematical wellbeing.

H2 Autonomy support positively influences students' mathematical wellbeing.

H3 Competence support positively influences students' mathematical wellbeing.

1.3. Social Support Theory

Social Support Theory explains that emotional and practical support from significant others can promote wellbeing and help individuals cope with stress. In school contexts, teachers, peers, and parents are important sources of support for students (Hoferichter et al., 2021). Their support may include care, encouragement, understanding, feedback, and academic assistance (Fan, 2024). These forms of support can help students regulate emotions and create more positive learning experiences (Wijaya, Rahmadi, et al., 2022).

In mathematics education, social support has been linked to higher classroom engagement (Haas et al., 2022), stronger confidence in mathematical ability (Acar et al., 2022),

and greater interest in mathematics (Hoferichter et al., 2021). Supportive interactions can also reduce mathematics anxiety and other negative emotions. This is closely related to the relationships dimension of mathematical wellbeing, which reflects students’ feelings of acceptance, care, and emotional connection in mathematics learning.

In this study, teacher support, peer support, and parent support are considered important contextual factors that may influence students’ mathematical wellbeing. When students receive guidance, encouragement, and understanding from these sources, they are more likely to feel confident, comfortable, and emotionally secure in learning mathematics (Riegle-Crumb et al., 2017). Therefore, each source of social support is expected to make a meaningful contribution to students’ mathematical wellbeing. The proposed relationships are shown in Figure 1.

H4 Peer support positively influences students’ mathematical wellbeing

H5 Parent support positively influences students’ mathematical wellbeing

H6 Teacher support positively influences students’ mathematical wellbeing

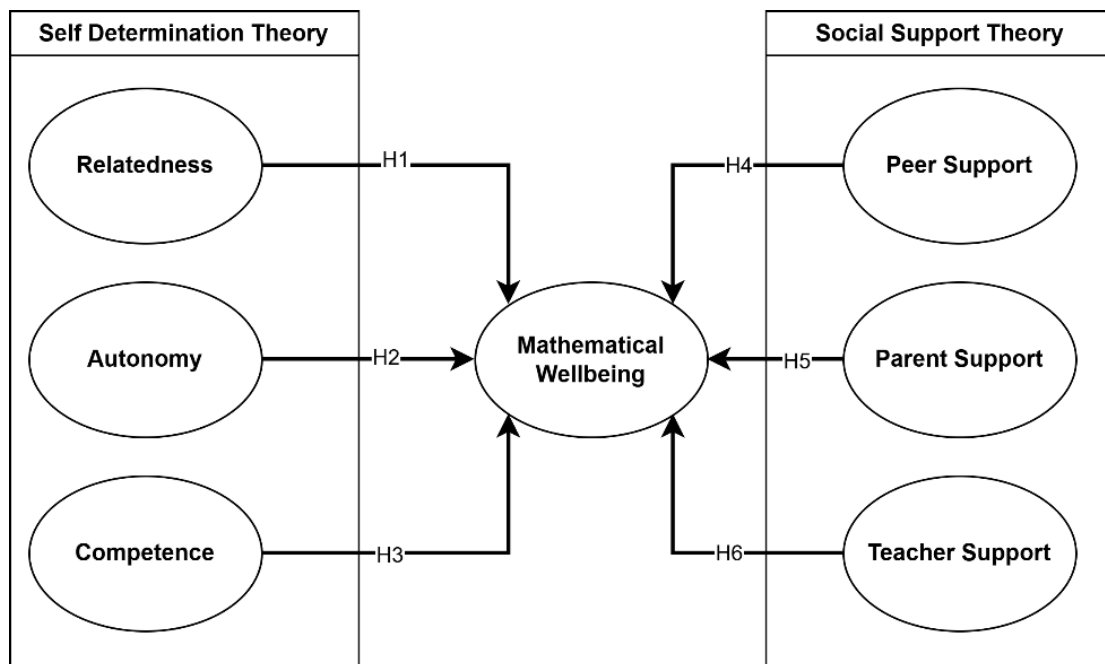


Figure 1. Conceptual model of factors influencing students’ mathematical wellbeing

2. METHOD

2.1. Data collection and participants

Data were collected from 449 secondary school students in City P, Indonesia, with institutional approval and support from teachers in six participating schools. The sample included students from Grades 7–12 (Grade 7: 101; Grade 8: 65; Grade 9: 84; Grade 10: 55; Grade 11: 95; Grade 12: 49), representing both junior and senior secondary levels (see Figure 2). Of the participants, 258 were female and 191 were male. Outside school, 233 students studied mathematics for 1–2 hours, 59 studied for more than 3 hours, and 157 studied for less than 1 hour.

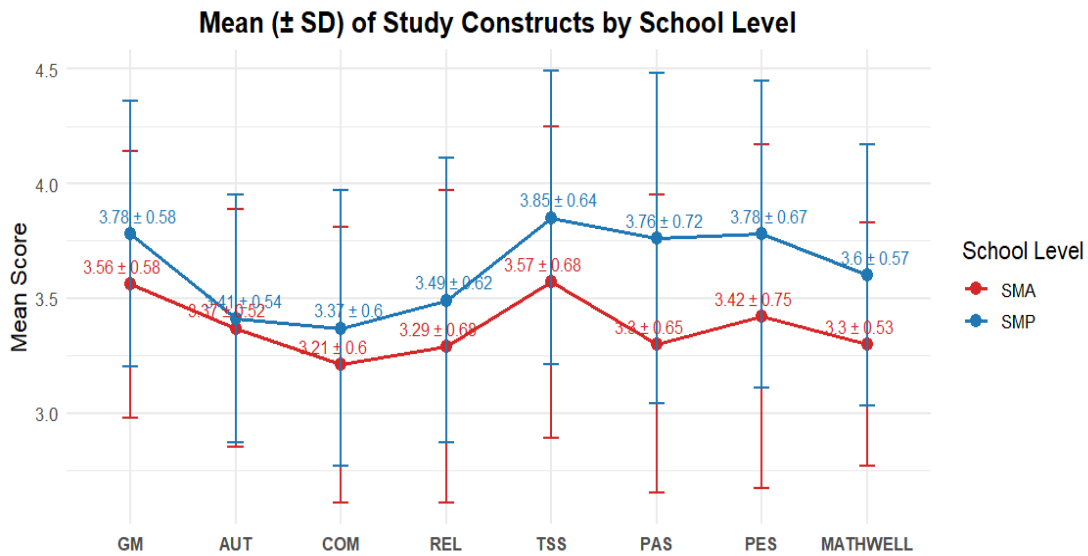


Figure 2. Mean scores and standard deviations of all constructs by school level

This study employed a convenience sampling approach. however, student participation was entirely voluntary. Prior to data collection, students were informed about the purpose of the study. Teachers in the participating schools were fully aware of the research objectives and procedures and provided informed consent as part of the ethical approval process. All data collection procedures were conducted in accordance with established ethical standards for educational research. After data cleaning and screening, responses were excluded if they showed overly uniform answers across items, were incomplete, failed the attention-check questions, or were completed unusually quickly. As a result, 449 valid samples were retained for analysis.

2.2. Instrument

Composite reliability for all constructs was assessed using McDonald's coefficient omega (ω), computed in RStudio using the psych package. This approach provides a more robust estimate of internal consistency than Cronbach's alpha, particularly when the assumption of tau-equivalence is violated (Morales-García et al., 2024). All instruments used a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Autonomy, competence, and relatedness were measured using three items each, adapted from previous research (Gao et al., 2025). Autonomy demonstrated relatively low internal consistency ($\omega = 0.569$, $M = 3.39$, $SD = 0.53$). Sample items included "I feel that I can choose how to learn mathematics (e.g., strategies, tools)" and "I have a voice in the use of digital/AI tools when learning mathematics." Because autonomy was measured with three items and reflects a context-dependent perception, lower reliability estimates may occur. We therefore relied on the broader measurement-model evaluation (indicator loadings, composite reliability, and convergent validity) to confirm the adequacy of this construct in the PLS-SEM model. Competence showed marginal internal consistency ($\omega = 0.677$, $M = 3.30$, $SD = 0.60$) and captured students' beliefs about their ability to successfully engage with mathematical tasks. Sample items included "I feel capable of mastering the mathematics topics being

studied” and “I am confident that I can perform well on mathematics tasks or tests.” Relatedness exhibited acceptable reliability ($\omega = 0.720$, $M = 3.40$, $SD = 0.65$) and represented students’ perceived connectedness with others in the mathematics learning context. Example items were “I feel connected to the people learning mathematics with me” and “I feel that I am part of my mathematics class.”

Teacher support was measured using three items, adapted from prior studies (He et al., 2025), and showed acceptable internal consistency ($\omega = 0.713$, $M = 3.73$, $SD = 0.67$). The scale assessed students’ perceptions of emotional and instructional support provided by mathematics teachers. Sample items included “My teacher encourages and helps me when I have difficulties in mathematics” and “My teacher gives clear feedback so that I know how to improve my mistakes in mathematics.” Parent support and peer support were each assessed using three items, adapted from existing instruments (Gao et al., 2025), and demonstrated good internal consistency (PAS: $\omega = 0.801$, $M = 3.56$, $SD = 0.72$; PES: $\omega = 0.801$, $M = 3.62$, $SD = 0.73$). Parent support captured students’ perceptions of encouragement and learning resources provided by parents or guardians, with sample items such as “My parents/guardians show interest in my progress in mathematics” and “My parents/guardians encourage me when I face difficult mathematics tasks.” Peer support reflected support received from classmates, with example items including “My classmates are willing to explain or discuss mathematics problems” and “My classmates give support that makes me more confident in mathematics.”

Mathematical wellbeing was measured using items adapted from established measures (Hill & Hunter, 2024; Hunter & Hill, 2024), and exhibited high internal consistency ($\omega = 0.877$, $M = 3.47$, $SD = 0.57$). The items assessed students’ positive emotional experiences, satisfaction, and overall psychological functioning in relation to mathematics learning. Sample items included “I feel I am making progress toward my goals in mathematics,” “When learning something new in mathematics, I feel very interested,” and “I feel that learning mathematics has purpose and meaning for me”.

2.3. Data Analysis

This study employed Partial Least Squares Structural Equation Modeling (PLS-SEM) to analyze the proposed research model, using SmartPLS software. The choice of PLS-SEM was guided by several methodological considerations, including sample size, data distribution, and model complexity (Hair et al., 2019).

First, the sample size in this study is relatively small for covariance-based structural equation modeling (CB-SEM), which typically requires large samples to ensure stable parameter estimation and reliable global model fit indices. In contrast, PLS-SEM is well suited for studies with small to medium sample sizes, as it relies on a variance-based estimation approach and does not impose strict sample size requirements (Wang et al., 2022).

Second, the data did not meet the assumption of normality. Normality testing indicated that several constructs showed substantial deviations from normal distribution, with skewness values exceeding ± 1 and kurtosis values greater than 3. In addition, Q–Q plot inspection suggested the absence of multivariate normality. Because CB-SEM assumes multivariate normality, applying it under these conditions may lead to biased estimates and unreliable

statistical inferences. PLS-SEM, however, does not rely on normal distribution assumptions, making it more appropriate for analyzing non-normally distributed data (Hair et al., 2019).

Third, the proposed research model is relatively complex, involving six structural paths and the integration of two theoretical frameworks into a single analytical model. Such complexity increases the risk of model estimation problems in CB-SEM, especially when sample size and distributional assumptions are not fully met. PLS-SEM is particularly suitable for complex models, as it can simultaneously estimate multiple latent constructs and direct and indirect relationships without requiring strong distributional assumptions (Hair et al., 2019).

Moreover, this study adopts a prediction-oriented and exploratory approach, aiming to explain variance in key outcome variables rather than to achieve optimal global model fit. Unlike CB-SEM, which focuses primarily on theory confirmation and overall model fit, PLS-SEM emphasizes variance explanation and predictive accuracy, making it well aligned with the objectives of the present study (Hair et al., 2019).

Following established guidelines, the PLS-SEM analysis was conducted in two stages: measurement model evaluation and structural model evaluation (Hair et al., 2019). The measurement model assessment examined indicator reliability, internal consistency, and convergent validity, while the structural model assessment focused on path coefficients, explained variance, and hypothesis testing. Bootstrapping with 5,000 resamples was applied to assess the statistical significance of the structural paths, using a significance level of 0.05.

3. RESULTS AND DISCUSSION

3.1. Results

In this study, the measurement model was evaluated in terms of reliability and construct validity to ensure that all latent variables were measured appropriately. The results of the reliability and convergent validity analyses are presented in [Table 1](#), while discriminant validity is reported in [Table 2](#).

Table 1. Reliability and convergent validity of the measurement model

Construct	items	Loading	Cronbach's α	Composite reliability	AVE
Teacher Support	TSS3	0.860	0.674	0.823	0.615
	TSS2	0.873			
	TSS1	0.586			
Peer Support	PES3	0.864	0.799	0.881	0.713
	PES2	0.806			
	PES1	0.861			
Parent Support	PAS3	0.834	0.800	0.882	0.714
	PAS2	0.850			
	PAS2	0.851			
Relatedness	REL3	0.792	0.714	0.840	0.637
	REL2	0.832			
	REL1	0.769			

Construct	items	Loading	Cronbach's α	Composite reliability	AVE
Competency	COM3	0.830	0.671	0.819	0.603
	COM2	0.780			
	COM1	0.715			
Autonomy	AUTO3	0.834	0.565	0.767	0.528
	AUTO2	0.582			
	AUTO1	0.742			
Math Wellbeing	MATHWELL1	0.760	0.877	0.907	0.619
	MATHWELL2	0.815			
	MATHWELL3	0.800			
	MATHWELL4	0.828			
	MATHWELL5	0.748			
	MATHWELL6	0.767			

All standardized factor loadings were acceptable, ranging from 0.58 to 0.87, indicating that the items adequately represented their intended constructs. Internal consistency was assessed using Cronbach's alpha and composite reliability (CR). Across constructs, Cronbach's alpha values ranged from 0.57 to 0.88, while CR values ranged from 0.77 to 0.91, suggesting acceptable to good internal consistency overall. Although the autonomy construct showed a lower alpha value, its composite reliability exceeded the recommended threshold, and its convergent validity was adequate ($AVE > 0.50$), supporting the reliability of the scale despite the small number of items.

Table 2. Discriminant validity assessment using the fornell-larcker criterion

	Autonomy	Competency	Mathematical Well being	PAS	PES	Relatedness	TS
Autonomy	0.727						
Competency	0.540	0.777					
Mathematical Well-bing	0.535	0.689	0.787				
PAS	0.430	0.506	0.661	0.845			
PES	0.370	0.460	0.617	0.515	0.844		
Relatedness	0.441	0.606	0.707	0.533	0.558	0.798	
TS	0.437	0.496	0.582	0.547	0.584	0.534	0.784

Convergent validity was examined using the average variance extracted (AVE). As shown in [Table 1](#), all AVE values were above the recommended cutoff of 0.50, ranging from 0.53 to 0.71, which indicates that each construct explained more than half of the variance in its indicators. Discriminant validity was assessed using the Fornell–Larcker criterion (Fornell & Larcker, 1981). The results in [Table 2](#) show that the square root of the AVE for each construct was greater than its correlations with other constructs, supporting adequate discriminant validity.

Overall, these findings demonstrate that the measurement model exhibits satisfactory reliability, convergent validity, and discriminant validity, and is therefore suitable for subsequent structural equation modeling analyses.

In line with recommendations for PLS-SEM, model fit was evaluated using the standardized root mean square residual (SRMR). The SRMR value of 0.066 suggests that the model fits the data adequately.

With the overall model fit established, the structural relationships were subsequently examined. The results of the structural model are reported in Table 3, and the final model with standardized path coefficients and explained variance is illustrated in Figure 3.

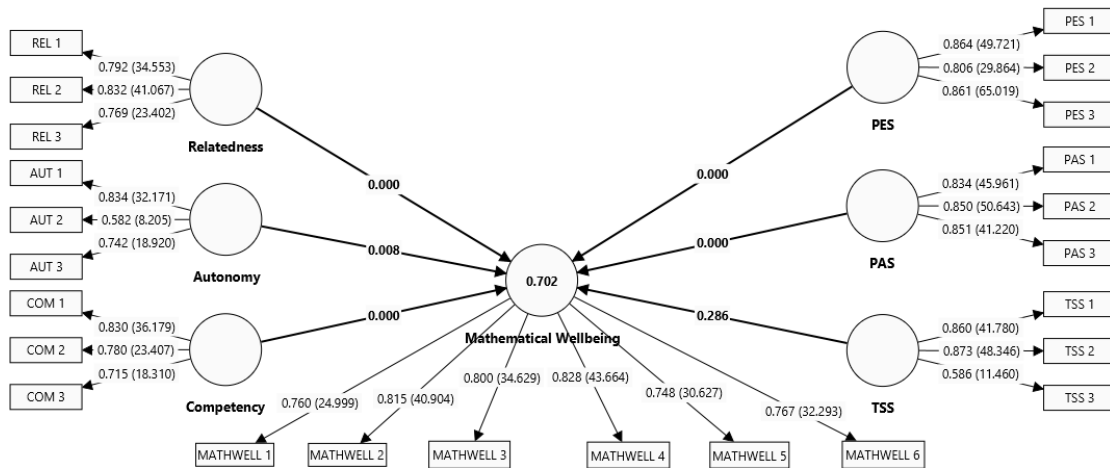


Figure 3. Final structural model with path coefficients, p-values, and R²

The bootstrapping results provide clear support for most of the hypothesized relationships. H1 shows that relatedness is a significant positive predictor of mathematical wellbeing ($\beta = 0.265$, $t = 5.770$, $p < 0.001$). This indicates that students who feel more connected and supported in their mathematics learning tend to report higher wellbeing in mathematics. H2 is also supported: autonomy has a positive and significant association with mathematical wellbeing ($\beta = 0.096$, $t = 2.660$, $p = 0.008$). However, the effect is the smallest among the significant predictors, suggesting that autonomy contributes to mathematical wellbeing but with a more modest influence compared to other factors. H3 is supported as well: competency is positively related to mathematical wellbeing ($\beta = 0.259$, $t = 5.901$, $p < 0.001$), meaning that students who feel capable and confident in mathematics are more likely to experience better psychological functioning and positive feelings in mathematics learning. Overall, among the SDT-related predictors, relatedness and competency show stronger effects than autonomy, implying that feeling connected and feeling capable may be more central correlates of mathematical wellbeing in this sample.

Table 3. Bootstrapping results for hypothesis testing

Hypothesis	β	Mean	SD	T-value	P values
H1: Relatedness -> Mathematical Wellbeing	0.265	0.264	0.046	5.770	0.000
H2: Autonomy -> Mathematical Wellbeing	0.096	0.097	0.036	2.660	0.008
H3: Competency -> Mathematical Wellbeing	0.259	0.260	0.044	5.901	0.000

Hypothesis	β	Mean	SD	T-value	P values
H4: PES -> Mathematical Wellbeing	0.167	0.166	0.040	4.142	0.000
H5: PAS -> Mathematical Wellbeing	0.238	0.237	0.040	5.949	0.000
H6: TS -> Mathematical Wellbeing	0.043	0.045	0.040	1.068	0.286

For the social support hypotheses, the findings indicate that peer emotional support and parental support are both meaningful correlates of mathematical wellbeing. H4 is supported: peer emotional support positively predicts mathematical wellbeing ($\beta = 0.167$, $t = 4.142$, $p < 0.001$), suggesting that encouragement and emotional help from peers may enhance students' positive experiences and functioning in mathematics. H5 is strongly supported: parental support has a significant positive effect on mathematical wellbeing ($\beta = 0.238$, $t = 5.949$, $p < 0.001$), indicating that students who perceive greater support from parents tend to show higher wellbeing in mathematics, likely because parents provide reassurance, motivation, and learning-related assistance. In contrast, H6 is not supported: teacher support does not significantly predict mathematical wellbeing ($\beta = 0.043$, $t = 1.068$, $p = 0.286$). This suggests that, within this dataset, perceived teacher support may not uniquely explain variation in mathematical wellbeing once other factors (needs and family/peer support) are included in the model. A plausible interpretation is that teacher support may operate indirectly (e.g., through competence or relatedness), may be less salient than family/peer support in this context, or its effect may be shared with other predictors, reducing its unique predictive power in the structural model (see Table 3). Taken together, these results suggest that students' mathematical wellbeing is significantly associated with both basic psychological needs (autonomy, competence, and relatedness) and social support from peers and parents, whereas perceived teacher support does not show a direct effect in the present model.

Beyond the significance of individual structural paths, the explanatory power of the model was also examined using the coefficient of determination (R^2). The results show that mathematical wellbeing had an R^2 value of 0.702, indicating that autonomy, competence, relatedness, peer emotional support, parent support, and teacher social support jointly explained 70.2% of the variance in students' mathematical wellbeing. This represents a strong level of explanatory power, suggesting that the proposed model captures a substantial proportion of the factors associated with students' mathematical wellbeing. In other words, students' mathematical wellbeing can be well explained by the combined influence of their basic psychological needs and social support from important people in their learning environment. This finding strengthens the relevance of the model and shows that both internal psychological factors and external contextual support are important for understanding students' wellbeing in mathematics learning.

This relatively high R^2 value suggests that the proposed model demonstrates strong explanatory capacity (Hair et al., 2019), capturing a substantial proportion of the factors associated with mathematical wellbeing. In particular, the combined contribution of basic psychological needs and social support resources provides a comprehensive account of students' wellbeing in mathematics learning. Although teacher social support did not show a significant direct effect, the overall set of predictors meaningfully explains variation in mathematical wellbeing, supporting the adequacy of the proposed structural model.

3.2. Discussion

The findings indicate that autonomy positively associated with students' mathematical wellbeing, thereby supporting Hypothesis 1. When students perceive greater choice and control in their learning, they are more likely to experience positive emotions, satisfaction, and psychological comfort in classroom (Frenzel et al., 2007; Niemiec & Ryan, 2009). Opportunities to make decisions, explore different problem-solving strategies, and take ownership of learning foster a sense of agency, which enhances students' engagement and overall mathematical wellbeing. More importantly, this may have a meaningful impact on students' mathematics learning. Students with higher autonomy and mathematical wellbeing are more likely to participate actively, persist when facing difficult problems, and develop confidence in their mathematical ability. These conditions can support deeper understanding, more flexible problem-solving, and sustained motivation to learn mathematics. Thus, autonomy does not only contribute to students' wellbeing but also creates a psychological foundation for more productive mathematics learning.

From a practical perspective, these findings suggest that mathematics instruction should provide students with opportunities to learn in ways that align with their interests and preferences. At the secondary school level, students are in adolescence and are increasingly capable of making decisions about their own learning (Liu & Helwig, 2022; Ware & Kessler, 2016). Teachers are therefore encouraged to adopt the role of facilitators, rather than sole knowledge transmitters, by allowing students to choose among different tasks, strategies, or representations when solving mathematical problems. Using a variety of instructional approaches and learning models can further support students' autonomy. By giving students the space to explore, choose, and discover solutions independently, mathematics learning can become more meaningful and supportive of students' mathematical wellbeing.

The results also show that competence positively associated with mathematical wellbeing. Feeling capable of understanding mathematical concepts and successfully completing tasks contributes to students' confidence and reduces negative emotional experiences such as frustration or anxiety. Experiences of mastery and effectiveness enable students to develop a sense of accomplishment in mathematics learning, which in turn supports higher levels of mathematical wellbeing (Fadji & Reddy, 2023; Goldin et al., 2011).

From a practical standpoint, these findings highlight that strengthening students' basic mathematical skills is a key strategy for enhancing both competence and mathematical wellbeing. Ensuring that students have a solid foundation in fundamental mathematical concepts and procedures allows them to approach more complex tasks with greater confidence (Torres-Peña et al., 2025). Teachers are encouraged to provide structured practice, timely feedback, and graduated levels of difficulty so that students can experience consistent success. By reinforcing basic mathematics and gradually building toward more challenging problems, educators can help students develop a stable sense of competence, which ultimately promotes positive emotional experiences and sustained wellbeing in mathematics learning.

Relatedness is strongly linked to mathematical wellbeing. Supportive relationships with teachers and peers enable students to feel accepted, encouraged, and socially connected within the mathematics classroom (Mata et al., 2012). When students experience a sense of belonging, they are more likely to interpret challenges as manageable and to feel emotionally

secure when making mistakes. Such social environments foster positive emotional experiences and contribute meaningfully to students' mathematical wellbeing.

From a practical perspective, these findings highlight the importance of learning designs that promote interaction and collaboration. Group-based learning activities, particularly those grounded in STEM-oriented approaches (Videla et al., 2021), can provide meaningful opportunities for students to communicate, negotiate ideas, and solve problems collaboratively. Increasing the frequency and quality of teacher–student interactions as well as student–student interactions is a critical element in strengthening relatedness (Wijaya et al., 2025). When teachers actively facilitate discussion, encourage peer support, and create a classroom culture that values cooperation rather than competition, students are more likely to feel socially connected. Such collaborative learning environments not only enhance understanding of mathematical concepts but also play a crucial role in supporting students' mathematical wellbeing.

Regarding social support, both peer emotional support and parental support show significant positive associations with mathematical wellbeing. Students who feel emotionally supported by peers may experience less stress, more confidence, and stronger persistence when facing difficult mathematics tasks (Cunningham & Siegel, 1987). Consistent with Social Support Theory (Cohen & Wills, 1985), peer support can provide emotional comfort, encouragement, and a sense of togetherness, which is linked to more positive learning experiences (Bulotsky-Shearer et al., 2014). Similarly, parental support is positively associated with students' mathematical wellbeing. Even when parents cannot provide direct academic help due to time constraints or limited mathematical knowledge (Mei-Ju et al., 2014), which limits the time they can spend helping directly with mathematics tasks. Some parents may also feel that they do not have enough mathematical knowledge to guide their children through complex problems. Even so, parents consistently serve as a stable supporting system (Wijaya, Rahmadi, et al., 2022). They often remind their children about the importance of mathematics, the meaning of learning mathematics, the value of working hard, and the need to stay focused when solving mathematical tasks (Haas et al., 2022). These gentle reminders create encouragement that helps students feel cared for and emotionally supported.

This explanation is consistent with Social Support Theory (Cohen & Wills, 1985), which highlights that emotional reassurance and motivational messages from significant people can reduce stress and enhance well-being, even when the support is not academic in nature. Previous studies have also shown that parent support is positively linked to different aspects of student well-being, including emotional stability, motivation, and confidence (Hoferichter et al., 2021; Šimunović & Babarović, 2020). Therefore, parental support still contributes meaningfully by offering emotional security and positive encouragement, which help strengthen students' overall mathematical well-being.

The present study found that teacher support was not significantly associated with students' mathematical well-being, which differs from many earlier studies that reported positive effects of teacher support on students' academic outcomes (Wijaya, Cao, et al., 2022; Zhou et al., 2020). One possible explanation is that students may associate mathematics stress with their teachers, who are the ones giving challenging, difficult, or high-pressure tasks. Even though teachers aim to help students grow, the classroom structure, assessments, and

demanding exercises can make students feel that the teacher is also the source of their academic pressure. As a result, students might appreciate the academic guidance offered by teachers, but they may not interpret it as emotional comfort or support that reduces stress.

In this situation, teacher support becomes more connected to performance expectations rather than emotional well-being. Students may see teacher help as part of normal classroom instruction, not as something that directly improves how they feel about mathematics. Meanwhile, stress from homework, tests, and difficult problem-solving tasks may overshadow the supportive intention behind teacher guidance. This dynamic can weaken the emotional impact of teacher support on students' mathematical well-being.

Several recent studies have also shown that teacher support tends to influence academic achievement more strongly than emotional well-being (Yeigh et al., 2023), especially when classroom expectations are strict and mathematics tasks are perceived as demanding. Therefore, in this context, it is understandable that teacher support did not show a significant effect on students' mathematical well-being.

4. CONCLUSION

This study identified key factors influencing students' mathematical wellbeing and demonstrated that a combination of internal psychological needs and external social supports explains a substantial proportion (70.2%) of the variance in mathematical wellbeing among secondary school students. These findings confirm that mathematical wellbeing is shaped not only by students' learning experiences but also by the social contexts in which mathematics learning occurs.

By integrating Self-Determination Theory and Social Support Theory, the study provides empirical evidence that autonomy, competence, and relatedness, together with parent and peer support, play significant roles in fostering positive emotional experiences in mathematics. The results extend existing research by highlighting students' perspectives and by offering a comprehensive explanatory framework for understanding mathematical wellbeing in secondary education.

Overall, this study underscores that enhancing students' mathematical wellbeing requires balanced attention to both internal psychological needs and external social supports. By illuminating the combined influence of these factors, the study contributes to the growing literature on mathematical wellbeing and offers practical insights for educators and policymakers seeking to design more supportive, engaging, and sustainable mathematics learning environments.

Several limitations of this study should be acknowledged, and these also point to directions for future research. First, the data were drawn from secondary school students in a single national and regional context, with a relatively modest sample size. Because mathematics curricula, teaching practices, and cultural attitudes toward mathematics can differ substantially across countries and school systems, the generalizability of the present findings may be constrained. Future studies are therefore encouraged to replicate and extend the proposed model with larger and more diverse samples including students from different grade

levels, school tracks, and cultural backgrounds to test the cross-contextual robustness of the determinants of mathematical wellbeing.

Second, the study relied on cross-sectional self-report data. Although the hypothesized directions of effects were informed by Self-Determination Theory, and Social Support Theory, a cross-sectional design does not permit strong causal conclusions. Moreover, the exclusive use of a single method and a single informant raises the possibility of common-method variance. Future research would benefit from longitudinal or experimental designs that can better establish temporal ordering, as well as from the inclusion of multiple data sources (e.g., teacher reports, peer nominations, classroom observations, or achievement records) to triangulate students' self-reported experiences.

Third, although the measurement model generally showed acceptable psychometric quality, the autonomy construct demonstrated comparatively lower internal consistency (e.g., lower Cronbach's alpha). This may be partly due to the short three-item scale and the context-dependent nature of autonomy perceptions. Future studies should refine and further validate the autonomy measure in this context, for example by revising low-performing items, adding additional indicators to better capture the construct, and testing measurement invariance across student subgroups.

Finally, the structural model focused on a deliberately circumscribed set of predictors basic psychological needs and three sources of social support in order to test a theoretically coherent dual-pathway framework. This focus inevitably omits other potentially important determinants and mechanisms. For example, specific achievement emotions (e.g., anxiety, enjoyment, boredom), different forms of motivation, classroom instructional practices, and students' actual mathematics achievement or feedback from AI-based learning tools were not considered. Future research could extend the current framework by integrating these additional variables, testing more complex pathways (such as multiple mediators and moderators), and examining how targeted interventions for instance, autonomy-supportive teaching practices, growth-mindset programmes, or structured peer- and parent-support initiatives, causally influence mathematical wellbeing over time. Despite these limitations, the present study provides a useful starting point for theorizing and empirically examining the determinants of mathematical wellbeing and offers several promising directions for subsequent work in both traditional and AI-enriched mathematics learning environments.

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